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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Ho-Shang Lee

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EXAMINER

DIACOU, ARI M

ART UNIT

PAPER NUMBER

3663

DATE MAILED: 07/18/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.		Applicant(s)	
	10/773,943		LEE ET AL.	
	Examiner		Art Unit	
	Ari M. Diacou		3663	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 19 May 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,4-12,14-19,21-40,43 and 44 is/are pending in the application.
- 4a) Of the above claim(s) 34-40,43 and 44 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-12,14-19 and 21-33 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
 - I. Claims 1-2, 4-12, 14-19 and 21-33, drawn to a light emitting diode, classified in class 257, subclass 79+.
 - II. Claims 34-38, drawn to a method of making a semiconductor device, classified in class 438, subclass 22+.
 - III. Claims 39-40 and 43-44, drawn to a method of operating a semiconductor optical amplifier, classified in class 359, subclass 344.
2. Inventions III and I are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another and materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the method could be practiced on a semiconductor optical amplifier in a transmission system.
3. Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make another and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the method of making could produce a laser.

4. Inventions II and III are related as process of making and process of using the product. The use as claimed can be practiced with a materially different product, for instance a semiconductor optical amplifier. Since the product is not allowable, restriction is proper between said method of making and method of using.

5. During a telephone conversation with James Hsue on 7-10-2006 a provisional election was made without traverse to prosecute the invention I, claims 1-2, 4-12, 14-19 and 21-33. Affirmation of this election must be made by applicant in replying to this Office action. Claims 34-40 and 43-44 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

6. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

7. Applicant is advised that the reply to this requirement to be complete must include an election of the invention to be examined even though the requirement be traversed (37 CFR 1.143).

8. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Response to Arguments

9. In the remarks filed 5-19-2006, applicant argued the following:
- A. On page 13, that the claims 2 and 40 are enabled in the specification specifically referring to the enablement of incoherent light extraction and single-mode output. The applicant cited paragraphs [0005] [0006] [0017] [0020].
- B. On pages 13-16, that as amended, Erchak does not teach every feature of the claimed invention.
10. Argument A. is convincing the rejection is hereby withdrawn.
11. Argument B is moot in view of the new grounds of rejection, which has been necessitated by amendment.

Claim Rejections - 35 USC § 112

12. The following is a quotation of the first two paragraphs of 35 U.S.C. 112:
- The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.
- The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.
13. Claim 33 is rejected under 35 U.S.C. 112, first paragraph, as based on a disclosure which is not enabling. Information critical or essential to the practice of the invention, but not included in the claim(s) is not enabled by the disclosure. See *In re Mayhew*, 527 F.2d 1229, 188 USPQ 356 (CCPA 1976). Why one would drill PC holes

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through the active layer or leave the holes above the active layer is not included in the specification.

14. Claim 33 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. There is no mention of a plurality of active layers in the specification which is implied by the phrase "to a region between the substrate and the active layers".

15. Claim 33 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 33 states "the substrate layer has a band gap that is wider than that of the active layer" it is ambiguous as to whether the applicant is referring to the electronic or photonic bandgap. Furthermore it is essential to examination that the applicant give the directions that the bandgap must be larger in (Γ , M, Σ , Δ , K, or are the smallest parts of the complete gap being compared?)

Drawings

16. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the band structure diagrams of the active layer and the substrate must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 102

17. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States

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only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

18. Claims 1-2, 4-5, 7-12, 14-19 and 21-33 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Lin et al. (USP No. 6958494).

19. Claim 33 as best understood by the examiner, is rejected under 35 U.S.C. 102(b) as being anticipated by Joannopoulos et al. (USP No. 5955749). Joannopoulos discloses a solid state light emitting device comprising:

- an active layer emitting light in response to current injected into the layer; [506]
- a first structure adjacent to the active layer, said structure trapping the light generated by the active layer; [504]
- a substrate layer; and [502]
- a second structure adjacent to the first structure extracting the light that is trapped by the first structure, wherein the substrate layer has a band gap that is wider than that of the active layer, so that light emitted by the active layer is not absorbed significantly by the substrate layer, and so that light emitted by the active layer is emitted by both sides of the device, [These limitations cannot be examined before the drawing and 112 problems have been addressed].
- wherein the second structure comprises holes that extend through the first structure and the active layers to a region between the substrate and active layers, [the hole near feature 510 in Fig. 5 clearly shows the hole going through the active layer].

- wherein the light extracted by the second structure and outputted from the device is incoherent. [Joannopoulos discloses no mode-locking cavity, but does disclose the background art as being LEDs not lasers, therefore it is safe to assume that the output light is at least significantly comprised of incoherent light]

Claim Rejections - 35 USC § 103

20. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

21. Claims 1, 2, 4-5, 14-17, 28-29, 31-32, 39-40 and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al. (NPL) in view of Takeuchi et al. (USP No. 2001/0038656).

- Erchak discloses A solid state light emitting diode device comprising:
 - an active layer emitting incoherent light in response to current injected into the layer; [Inherent to an LED]
 - a second structure comprising a photonic crystal structure adjacent to the first structure extracting the incoherent light that is trapped by the first structure and outputting incoherent light. [Fig. 1, top layer]

but fails to disclose the extra waveguide layers and their Δ_n and positional relationships. Takeuchi teaches:

- a first structure comprising at least one waveguide layer adjacent to the active layer [25] and [27]

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- and two cladding layers wherein said active layer and said at least one waveguide layer are located between the two cladding layers, [28] and [24]
- wherein an index of refraction of said at least one waveguide layer is higher than that of the cladding layers, [Laws et al. shows that GaN inherently has a higher index of refraction than AlGaN]
- said structure trapping the incoherent light generated by the active layer; and [This is an inherent result of layering claimed materials in the claimed manner. Furthermore, [25] and [27] are called optical confinement layers]

Therefore, it would have been obvious to one skilled in the art (e.g. an optical engineer) at the time the invention was made, to add the extra layers of Takeuchi to the device of Erchak in the manner claimed, for the advantage of even greater light confinement capacity (see [¶ 0002-0004] of Takeuchi).

- *On claim 2:* the first structure contains substantially a single optical mode (935 nm in one embodiment and at 790 nm in another: see first column of page 565, second and third paragraphs, respectively) and traps the light in said optical mode.
- *On claim 4:* since in DBR layers their thickness approximately corresponds to one quarter of the wavelength this limitation is met by Erchak for the emission of 935 nm and also for the emission of 790 nm wavelength, corresponding to thicknesses equal to about 233 nm and 197.5 nm, respectively.

- *On claim 5:* the device by Erchak et al further comprises a transparent and conductive layer (Al_xO_y layer) over the first structure (second paragraph of first column of page 563).
- *On claim 14:* said photonic crystal structure comprises at least one array of holes in the device (first sentence of second paragraph of first column of page 563; see Fig. 1).
- *On claim 15:* said second structure comprises at least one layer (upper cladding layer; see second paragraph of first column of page 563), wherein the photonic crystal structure comprises at least one array of holes in said at least one layer (second paragraph of first column of page 563; Fig.1).
- *On claim 16:* said at least one array of holes forms a two-dimensional array (first sentence of second paragraph of page 563; see Fig. 1).
- *On claim 17:* as shown by Fukuda it is inherent for a light-emitting diode device to have at least one electrode through which current is injected into the active layer.
- *On claim 28:* said holes form a triangular array (second paragraph of first column of page 563, first sentence; see also Figs. 1 and 4).
- *On claim 29:* a lattice constant of said at least one array of holes is in a range of about 80 to 500 nm, namely: 380 nm (see second column of page 564), and the holes have diameters in the range of about 50 nm to 300 nm, namely: 112 nm (loc.cit.).
- *On claim 31:* the device further comprises a substrate (GaAs substrate: Fig. 1 and final three lines of first column of page 563).

- *On claim 32:* the substrate layer has a band gap wider than that of the active layer (because the band gap of InGaAs is less than that of GaAs, which follows from Vegard's Law and the fact that the band gap of InAs is less than that of GaAs; see Appendix G in S.M. Sze, "Modern Semiconductor Device Physics").

22. Claims 7-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak and Takeuchi as applied to claims 1, 2, 4-5, 14-17, 28-29, 31-32, 39-40 and 43 above, and further in view of common knowledge in the art (shown in the Wikipedia.com and luxpop.com references). Erchak and Takeuchi disclose the invention with all the limitations of claim 6, but fail to disclose the theory of antireflective coatings. The Wikipedia reference teaches basic optics principles that would have been obvious to anyone of skill in the art and contain enough information to construct an anti-reflective coating made of ITO including the limitations to the thickness (quarter wavelength) and refractive index (square root of the index of the layer below). Since InGaAs and a wavelength of 980 nm is being used by Erchak ($n(\text{GaAs}, \lambda=980 \text{ nm}, 300 \text{ K}) = 3.521$ $n(\text{InAs}, \lambda=980 \text{ nm}, 300 \text{ K}) = 3.664$) therefore all ternary combinations of the two will be between these two values. It is also known that ITO has an index of refraction close to the square root of that of InGaAs ($\sqrt{3.59} = 1.89 \sim n(\text{ITO}, \lambda=980 \text{ nm}, 300 \text{ K}) = 1.76$) Therefore, it would have been obvious to one skilled in the art (e.g. an optical engineer) at the time the invention was made, to optimize the thickness, and material of the thin film coating for the advantage of maximal transmittance.

23. **Claims 18-19 and 21** are rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al (as applied to claim 17 above) in view of Kung et al (6,420,732 B1). As detailed above, *claim 17 is anticipated by Erchak et al. Erchak et al do not necessarily teach* the further limitation on grid-shaped pattern or pattern with hexagonal openings according to claim 18. However, it would have been obvious to include said further limitation in view of Kung et al, who teach the electrode layer 52 to have a grid-shaped pattern conforming the pattern of the underlying contact layer with holes collinear with the holes therein to “further reduce the absorption of light” (col. 10, l. 12-28 in Kung et al: see Figures 4 and 24-26). *Motivation* thus derives at once from the improved extraction efficiency, which is the goal of Erchak et al. In the combined invention thus obtained claim 19 is met, because the second structure comprises a plurality of holes, each array located so that it is enclosed by a grid cell or exposed through a hexagonal opening (see Erchak et al, second paragraph of first column of page 563) said at least one patterned electrode layer, wherein each array extracts light from the first structure and causes the extracted light to escape through a corresponding hexagonal opening (60 in Kung et al; cf. Figures 6, 24-26) of the electrode layer , or an area bounded by adjacent strips 52 of a grid-shaped electrode layer (loc.cit.). With regard to claim 21, a triangular array is the inherent property of a photonic crystal with hexagonal holes as without said triangular array no translational invariance can be preserved, said translational invariance being a criterion for crystal property.(Bravais lattice).

24. **Claim 22-26 and 43-44** are rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al and Kung et al as applied to claim 18 above, and further in view of Baur et al (WO 01/91194 A1). Although neither Erchak et al nor Kung et al necessarily teach the further limitation as defined by claim 22, it would have been obvious to include said further limitation in view of Baur et al, who, in patent application drawn to a light-emitting device (abstract), hence closely related to the combined invention, teach the electrode layer 6 (page 14, lines 27-37) to comprise elongated strips forming a network (loc.cit.), wherein the width of the strips is in the range as claimed, namely 3 μm (loc.cit.), so as to increase the external quantum efficiency (see abstract) further by allowing a reduction of the portion of surface area covered by the electrode layer. *Motivation* immediately flows from the resulting increase in light yield.

25. **On claims 23-25**: although Erchak et al nor Kung et al necessarily teach the further limitation defined by claim 23 it would have been obvious to include said further limitation in view of Baur et al, who teach said LED to comprise a plurality of light emitting portions (in between the members of the mesh: see page 14, lines 27-37) or semiconductor chips, said at least one electrode layer comprising a network (page 14, line 35) on each chip enclosing at least one light extraction cell (necessarily defined here to be the cell with the nearest members of the electrode mesh as boundaries) so as to provide in spite of the need for providing electrical contact an increase in the light extraction efficiency (see abstract). When included in the combined invention said light extraction cells are the photonic crystal cells because light extraction takes place

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exclusively within the latter. In the combined invention including the teaching by Baur et al said network comprises a plurality of grid cells (units of the mesh), each enclosing a photonic crystal cell (claim 24), while the mesh is taught to be rectangular (see Figures 7 and 8) (claim 25), and while each grid cell has a dimension in a range substantially overlapping the range defined by claim 26, namely within 0.1 μm – 1 mm, being 3 μm (page 14, lines 35-36). Applicant is reminded in this regard that a *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art or when the ranges of a claimed composition do not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

Motivation to include the teaching by Baur et al thus immediately flows from the resulting increased light extraction efficiency.

26. **Claim 27** is rejected under 35 U.S.C. 103(a) as being unpatentable over Erchak et al (as applied to claim 17 above) in view of Kung et al (6,420,732 B1). As detailed above, claim 17 is anticipated by Erchak et al. However Erchak et al do not necessarily teach the further limitation defined by claim 27. However, it would have been obvious to include said further limitation in view of Kung et al, who teach to include a central electrode layer portion 53 of transparent oxide layer 52 (said portion 53 qualifies on its own as “the at least one electrode layer”) so as to provide an improved current blocking structure (col. 11, l. 3-19). *Motivation* to include the teaching by Kung et al derives from the increase in current arriving at the light-producing pn-junction (loc.cit.).

Conclusion

27. While patent drawings are not drawn to scale, relationships clearly shown in the drawings of a reference patent cannot be disregarded in determining the patentability of claims. See In re Mraz, 59 CCPA 866, 455 F.2d 1069, 173 USPQ 25 (1972).

28. The references made herein are done so for the convenience of the applicant. They are in no way intended to be limiting. The prior art should be considered in its entirety.

29. The prior art which is cited but not relied upon is considered pertinent to applicant's disclosure.

30. As to limitations which are considered to be inherent in a reference, note the case law of In re Ludtke, 169 U.S.P.Q. 563; In re Swinehart, 169 U.S.P.Q. 226; In re Fitzgerald, 205 U.S.P.Q. 594; In re Best et al, 195 U.S.P.Q. 430; and In re Brown, 173 U.S.P.Q. 685, 688.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ari M. Diacou whose telephone number is (571) 272-5591. The examiner can normally be reached on Monday - Friday, 8:30 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jack Keith can be reached on (571) 272-6878. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

AMD 7/10/2006



JACK KEITH
SUPERVISORY PATENT EXAMINER